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Assessment of cleaning and disinfection operations of equipments in a Moroccan artichoke processingand canning plant

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ABSTRACT

Monitoring the effectiveness of cleaning and disinfecting surfaces of equipment in direct contact with the fruit (Artichoke) was performed. At this level, the method of microbiological swab was arrested for the enumeration of the total flora. 240 samples were taken for analysis. And from surfaces 10 belonging to 10 different locations. It turned out that 40% of samples infected. The level of infection is high and the values obtained were highly significant ($p < 0.005$) compared to the threshold of acceptability of the method of control recommended. 40% is so important that it can harm the health of the employee or even the consumer. It comes out that the daily application of a procedure for cleaning and disinfecting surfaces/utensils/blouses in the presence of a written clearly explained to the operators and validated, is mandatory. Cleaning should be consistent to avoid accumulation of food debris on equipment surfaces. Processing units and keeps Artichoke as they are installed to meet the needs of a consumer society in constant growth, they may be generating serious harm to health.

KEYWORDS

Cleaning;
Disinfection;
Surface area;
Swabbing;
Infection;
Processing unit;
Keeps Artichokes.

INTRODUCTION

The huge and continuous growing demand for food safety has forced the food industry to apply adequately and effectively cleaning and disinfection of places, equipment, work surfaces and work clothes.

In addition a regular monitoring of the effectiveness of these operations is necessary. The concerned units must follow established and methods validated by national or international standards for microbiological testing. These means that are considered by company managers show their actual involvement in the operations respecting the good hygiene practices.

This study deals with the above recommendations. It aims to monitor the effectiveness of cleaning and disinfection of all

equipment in contact with the product. The samples shall be accomplished in 10 locations or sampling sites within a processing unit and canning artichokes in Morocco. The study was conducted during the year 2010 when production reached 2,700 tons.

MATERIAL AND METHODS

Hygiene audit

Operations of cleaning and disinfection of all places are carried out by an internal team. This team belongs to the same unit and is composed of eight women. The cleaning and disinfection are carried out daily in the evening at the end of working hours. Operations take place in five phases in the following order:

- Pick up the dry debris on all machines, floors, tools;
- Dumping of debris into waste containers. Which are emptied into containers away from the process chain;
- Washing the processing line (machines, floor, walls...) with a high pressure water washer;
- Hand rubbing of the processing line, using a brush, previously sprayed with a detergent and a degreaser;
- Disinfection and final rinse

These cleaning and disinfection steps that are described in the TABLE 1, are accompanied by a visual inspection. This operation is useful for us to judge the success of the operation of disinfection and rinsing. After visual inspection, cleaning and disinfection equipment are put in their place.

TABLE 1 : Conditions of use of cleaning and disinfection products

Product	Application	Time (minutes)	pH	Concentration in %	Temperature of the used product in °C
Soft care Alcoolpus : antiseptic	Alcoholic solution (liquid)	1	-	50	+20
Nobla : detergent	Liquid	-	7	1	20
Delladet : detergent disinfectant	Foam	5	10.6	1	20

Pre-wash and rinsing are carried out with a high pressure water washer for 30 minutes and at a temperature of 20°C. The water pressure is 20 bars an the distance between the nozzle and the surface varies from 1 to 3 meters.

Spots and amount of samples taken

We chose 10 spots as sampling points. We chose the surface of the sorting treadmill after washing, the floor of the washing area, the disinfected hands of women, the women's hands from the preparation area, the women's hands from the packing area, washed boxes, the hands of workers from the reception, the tunnel entrance and the exit of the tunnel.

Spots selection is based on the main possible contact with the product during the preparation process.

240 samples from 10 spots are brought to the laboratory for analysis. This is accomplished between March and June 2010. 4 microbiological analyzes are reserved for cleaning water. The other two measures were used to evaluate the hardness of water.

Microbiological method

Samples were collected and prepared in accordance with French regulations memo n° 2007-8275 of the 14th November 2007,[14], using the technique of wet swab on an area of $10cm^2$[8] defined by a sterile template specific for each surface. Each swab was collected in a nutritive vial.

The vial is then shaken before dilution. It is considered as mother solution. From this solution, a series of dilutions going until a 10^{-4} dilution was done. Counting of total aerobic mesophilic flora is done on PCA milieu (Plate Count Agar) after 72h of incubation at 30.

He results are expressed as colony forming units per ml (CFU/ml) of the original product. The resulting values are converted from CFU/ml to CFU per cm^2. The unit change is inspired by the French regulations (Memo n° 2007-8275 of the 14th November 2007[14]).

$N' = N \times 4$

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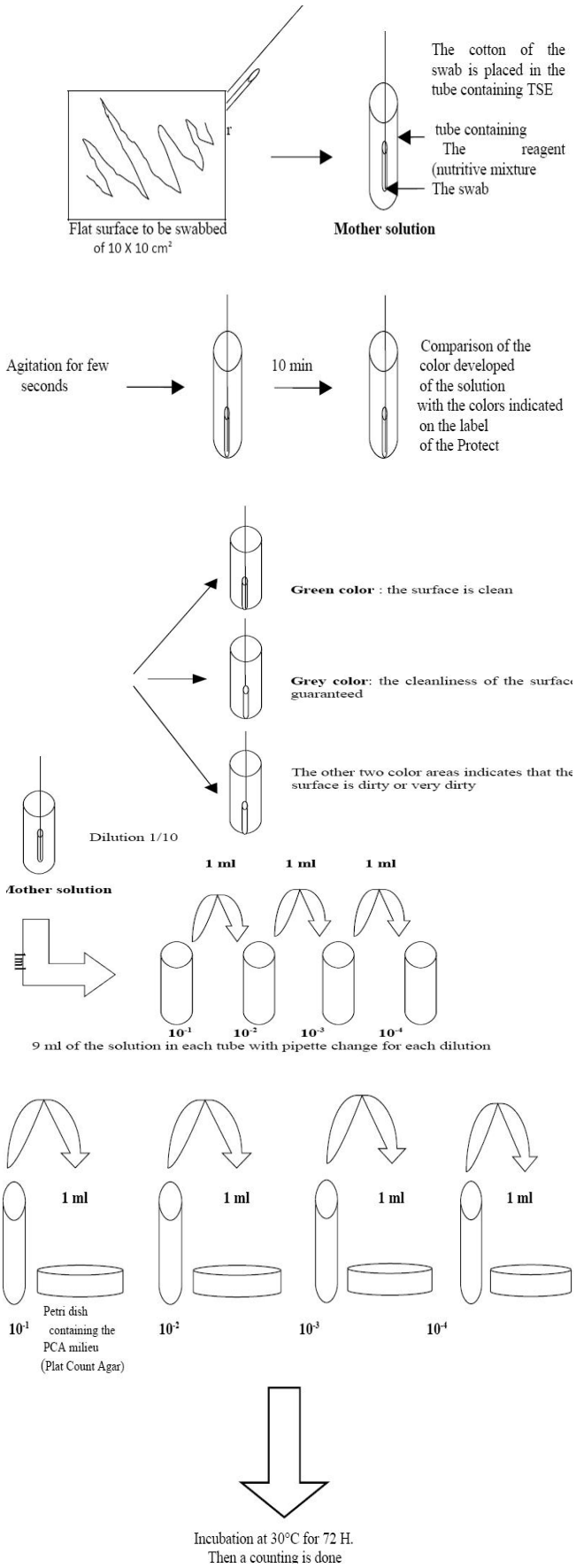

Sampling technic on the tested surface of the unit

N': number of CFU per cm^2

N: number of CFU per ml of the initial product

METHOD

Sampling

We removed the swab from the tube. The tube is turned on itself during sampling. To be representative, a stainless steel gauge of 10x10 was used to minimize flat surfaces. Within this gauge, our samples are made using two diagonal lines.

Traceability

To match the standard in this activity, we wrote on the tube: the name of the operator, the sampling location, the date and the time.

Inoculation and agitation

The cotton swab is placed in the TSE tube. The mixture is then quickly shaken for several seconds. The color of the solution turns mint green. We wait 10 minutes. We then compare the color developed in the solution with the identification label.

Reading

Green: the surface is clean

Gray: the surface cleanliness is not guaranteed

The other two color areas indicates that the surface is dirty or very dirty.

Statistical analysis of the data

The calculations are applied to the microbiological test results. For more numerical flexibility, the values of microbial abundances are transforme through the decimal logarithmic. The transformation aims to normalize the distribution [2,7].

The results are analyzed by type of surface. We calculated the mean and the standard deviation of microbial abundances for each surface.

Statistical analysis of the data

The calculations are applied to the microbiological test results. For more numerical flexibility, the values of microbial abundances are

TABLE 2: Results and actions that have to be done for each microbiological abundance.

Amount of microorganisms	Results/actions
Inferior to 1/cm²	Excellent
2 to 10 /cm²	Good
11 to 100/cm²	Clean the surface
Superior to 101 /cm²	Stop the production chain

Source: NF EN 1632 - 3, entitled: Methods of analysis and measurement of bio-contamination of surfaces in areas at risk, November 1998

transforme through the decimal logarithmic. The transformation aims to normalize the distribution [2,17].

The results are analyzed by type of surface. We calculated the mean and the standard deviation of microbial abundances for each surface. The averages have helped us to apply the threshold test of Student. This test reached a value of 5% and allowed us to make the comparison of means of the acceptability thresholds for each method.

The acceptability threshold chosen, in our case, is set by the French regulations (memo n^0 2007- 8275 of the 14th November 2007[14]).

RESULTS

Assessment of the TAMF

Monitoring the microbiological quality of contact surfaces is a main issue especially in food processing plants. The transformation of artichokes is an example. Indeed, it has microbiological tests with varied behavior. Referring to a standard can only be a tool for decision-making. The reference standard chosen for this activity is the NF EN 1632-3,[16], entitled: Methods of analysis and measurement of bio-contamination of surfaces in areas at risk, November 1998. The (TABLE 2) shows for each sampling site the number of microorganism, the results and the actions that have to be done.

Assessment of the microbiological amount

(TABLE 3) shows the abundance of the total aerobic mesophilic flora on 10 spots in the processing chain of a Moroccan company producing artichokes. It emerges from the average of 24 specimens for each site an abundance of microbial varying from 1.21 to 52.71 cfu/cm^2. The two values correspond respectively to the surface of the sorting treadmill at the washing exit and the o the hands of workers.

Both limits are between the good condition of the sorting surface at the washing exit and the hands of workers in the preparation area to clean. Such a result can only be reassuring. Slight improvements concerning cleaning would be responsible for obtaining a healthy and safe product.

Ns: not significant
Hs: highly significant
S : significant

Assessment of thermotolerant coliforms

TABLE 3 : Assessment of the abundance de l'abondance de la flore mésophile aérobie totale dans les 10 sites de prélèvements le long de la chaine de transformation des artichauts.

Spot type	Number of samples per site	TAMF	
		Mean ± standard deviation (log10 UFC/c²)	Statistcal analysis
Surface of the sorting treadmill after the washing exit	24	1,21 ± 0,41	Ns
Floor of the washing area	24	23,63 ± 0,49	S
Disinfected worker's hands	24	1,25 ± 0,44	Ns
Worker's hands of the preparation area	24	52,71 ± 0,46	Hs
Worker's hands of the packaging area	24	1,38 ± 0,49	Ns
Washed boxes	24	1,33 ± 0,48	Ns
Worker's hands of the cleaning area	24	24,58 ± 0,65	S
Tunnel entrance	24	1,29 ± 0,46	Ns
Tunnel exit	24	1,29 ± 0,46	Ns
Washing machine	24	25 ± 0,59	S

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Monitoring the hygienic quality of contact surfaces in the processing unit can reassure us about the degree of compliance of the company towards hygiene respect. For that, analyses of thermotolerant coliforms were completed. The reference standard chosen for this activity is the NF EN 1632-3[16], entitled: Methods of analysis and measurement of bio-contamination of surfaces in areas at risk, November 1998. (TABLE 4) shows for each site the number of samples taken and microorganisms associated with it.

We see through the reading of the values recorded on the table that, thermotolerant coliforms tests are negative in all sites examined. This can be explained by the effectiveness of the cleaning program against this type of microorganism. Similarly, this observation can be caused by the cold which avoid the multiplication of this type of. We report the case of the entry and the exit of the tunnel. At this level, the temperature is -18C.

Assessment of staphylococcus aureus

(TABLE 5) shows the degree of contamination of contact surfaces of the artichokes' transformation chain by the specie Staphylococcus aureus. It appears from reading the table a change in the number of microorganisms according to the site considered. However, the average is between 2 and 10 cfu/ cm^2. The abundances obtained are below the critical limits. This allows us to conclude that the cleaning program adopted by the company is efficient for this type of microorganism.

TABLE 4: Assessment of the abundance of thermotolerant coliforms in the 10 sampling spots along the artichoke processing chain.

Spot type	Number of samples per method	C.T.S thermotolerant coliforms	
		Mean ± standard Deviation (log10 UFC/cm²)	Statistical analysis
Surface of the sorting treadmill after the washing exit	24	0	
Floor of the washing area	24	0	
Disinfected worker's hands	24	0	
Worker's hands of the preparation area	24	0	
Worker's hands of the packaging area	24	0	
Washed boxes	24	0	
Worker's hands of the cleaning area	24	0	
Tunnel entrance	24	2	
Tunnel exit	24	0	
Washing machine	24	0	

TABLE 5 : Assessment of the abundance of Staphilococcus aureus in the 10 sampling sites along the artichoke processing chain.

Spot type	Number of samples per method	S.T.P staphylococcus aureus	
		Mean ± standard deviation (log10 UFC/cm²)	Statistical analysis
Surface of the sorting treadmill after the washing exit	24	0	
Floor of the washing area	24	3	
Disinfected worker's hands	24	0	
Worker's hands of the preparation area	24	0	
Worker's hands of the packaging area	24	0	
Washed boxes	24	0	
Worker's hands of the cleaning area	24	10	
Tunnel entrance	24	2	
Tunnel exit	24	0	
Washing machine	24	0	

Assessment of yeast

En analysant le tableau 5, relatant l'abondance des levures dans dix sites de l'unité de conservation des artichauts, il sort que les mains des ouvrières dans la zone de préparation détiennent une abondance de levures qui dépasse la norme. Le nombre est de 66 ufc/cm^2. Ceci met en péril le programme de nettoyage adopté dans l'unité. Face à cela, il est recommandé de revoir le programme adopté, appliquer fidèlement le mode d'emploie des solutions de nettoyage sinon changer le type de solution de nettoyage utilisée. A cela doit s'ajouter un programme de formation au profit des ouvrières et l'affichage des clips shart ou fiches d'instruction en relation avec les bonnes pratiques d'hygiènes.

By analyzing the (TABLE 6), describing the abundance of yeast in ten sites of the canning unit of artichokes, we see that the hands of workers in the preparation area have a yeast abundance that exceeds the standard. The number is 66 cfu/cm^2. This can fail the adopted cleanup program in the plant. Therefore it is recommended to review the program adopted and to strictly apply the notice when using cleaning solutions otherwise it is possible to change the type of cleaning solution used. Added to this, a training program benefiting to workers has to be set up and also posting clips or instruction sheets in related to good hygiene practices are necessary.

Assessment of fungi

For fungi, the (TABLE 7) shows no matters concerning fungi. The values of their abundances do not trigger any corrective action. All values are within the standard.

TABLE 6 : Assessment of the yeast abundance in the 10 sampling spots along the artichoke processing chain.

Spot type	Number of Samples per method	YEASTS	
		Mean ± standard deviation log10 UFC/cm²)	Statistical analysis
Surface of the sorting treadmill after the washing exit	24	0	
Floor of the washing area	24	0	
Disinfected worker's hands	24	0	
Worker's hands of the preparation area	24	66	
Worker's hands of the packaging area	24	0	
Washed boxes	24	0	
Worker's hands of the cleaning area	24	0	
Tunnel entrance	24	0	
Tunnel exit	24	0	
Washing machine	24	0	

TABLE 7 : Assessment of the fungi abundance in the 10 sampling spots along the artichoke processing chain.

Spot type	Number of samples per method	FUNGI	
		Mean ± standard Deviation (log10 UFC/cm²)	Statistical analysis
Surface of the sorting treadmill after the washing exit	24	0	
Floor of the washing area	24	0	
Disinfected worker's hands	24	0	
Worker's hands of the preparation area	24	0	
Worker's hands of the packaging area	24	0	
Washed boxes	24	0	
Worker's hands of the cleaning area	24	0	
Tunnel entrance	24	0	
Tunnel exit	24	0	
Washing machine	24	0	

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DISCUSSIONS

The thresholds levels of acceptability of CFU are presented in (TABLE 2). The results of the total flora show that the level of contamination of surfaces tested (floor, washing area, workers' hands and preparation's hands) is high and does not match the legal standard. Statistical analyzes performed by type of surface, reveal a highly significant difference ($p<0.05$).

Microbiological analyzes of cleaning water showed that the microbiological quality of water is good and meets the microbiological criteria for drinking water. The tests of the hardness of the water showed that water is fresh. The hydrometric degree HT is equal to 14(French degrees).

Contamination levels obtained by counting the total flora are significantly higher on four spots chosen and on one spot chosen for yeasts concerning thresholds levels.

This difference may be due to the poor quality of cleaning and disinfection procedures applied, the presence of old materials and the irregular cleaning and disinfection[13].

The company of fruits and vegetables canning practice a daily pre-cleaning and apply one to two times daily the complete operation of cleaning and disinfection immediately after the end of the operations of preparation and packaging of products. We noticed that even after applying the cleaning and disinfection, the presence of organic matter on the washed floor surface is still occurring. This increases the risk of fouling[3,11] floor contamination and therefore biofilm formation, which indeed show an increased resistance to the action of cleaning and disinfection [4,5,8].

Hands of the preparation workers indicate a high level of contamination by the total microbial flora compared with the standard. This can be explained by a lack of hygiene compliance or a lack of adequate training on the issue of hygiene. The flora associated to the hands of workers can result from a bad washing and rinsing of the raw material at the reception, a lack of information panels and restrictive in relation to hygiene and safety. Signs shall be placed at key locations visible and comprehensible[15]. The lack or poor application instructions for cleaning and disinfecting hands after each stop or return to handling the product or after using the toilet is also a means of contraction of germs[9]. Lack of cleaning and disinfection products, the underdosing of the same products or lack of training for staff about good hygiene practice are other factors in the spread and dissemination of germs[1,12].

The hands of workers in the washing area also show a high level of total microbial flora compared with the standard. The microbial abundance is slightly moderate compared to the preparation area. This position must have the same recommendations previously imposed. If microbial abundance is reduced very slightly, this is probably due to washing and rinsing with water applied to the treated product processing.

The floor in the area of washing is heavily contaminated. The microbial load there exceeds the standard. The result can be explained by the type of the cleaning and disinfection products that are used, the dose used the existence and the subsequent formation of cracks, the existence and formation of cavities and pores that are responsible of the creation of good settlement and nesting conditions for microorganisms[10].

CONCLUSION

According to this study, it appears that the establishment of procedures and instructions for adequate and effective cleaning and disinfection of facilities, equipments, products and staff is fundamental. It is a way to fight malwares such as food debris, contamination and other. It is also a mean of mitigating the risk of spreading hazards.

The correct application and periodic instructions and procedures for cleaning and disinfection at every stage and level of each type of surface is the best way to fight against different types of contamination found on the hands of workers and on other sites.

Recurrent and appropriate training for employees or for the cleaning and disinfection team is also another way of fighting all harmful microbial dangers.

Using the swab hygiene control method is very important. It informed us about the

effectiveness of cleaning and disinfection adopted at the company level[6]. This is a tool for decision making that has to be available for managers to better monitor and validate all operation system of cleaning and disinfecting coming from their jobs.

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